Homeland Security in Region 1

Background

Region 1 is currently serving as the Office of Research and Development's (ORD) lead region for homeland security. In order to assist Region 1 with this role, ORD's National Homeland Security Research Center (NHSRC) has conducted two major workshops in the Region with the objectives of discussing their current research and understanding the region's research needs. NHSRC's research program has been developed to provide relevant and timely information, technologies and tools to water utilities, responders/on-scene coordinators and government agencies to assist with the protection of public health and the environment, following a homeland security event.

The first workshop, conducted in May, 2007 focused on NHSRC's research in support of the Office of Water's (OW) Water Security Initiative. The second workshop, conducted in July, 2007 covered laboratory response to homeland security events, NHSRC's radiological research, new technologies for detection and decontamination, risk assessment and clean-up goals and the role and activities of the National Decontamination Team.

Science

OW is responsible for creating a robust water surveillance program as required by Homeland Security Presidential Directive 9. The first workshop included several presentations on how NHSRC is supporting this effort by testing commonly used water quality sensors to determine which are capable of detecting changes in water caused by contaminants of concern in terrorism. Further, NHSRC has enhanced the EPA developed water distribution system model, EPANET, such that the model can predict the fate of multiple contaminants and their interactions both with water and pipe walls. Additional modeling tools have been developed to guide the optimal placement of sensors and to interpret "hits" detected by those sensors.

The second workshop provided product awareness to Region 1 on risk analysis, evaluation of commercially available decontamination technologies, and experimental decontamination technologies and testing of commercially available decontamination technologies. Further, NHSRC demonstrated its program for establishing advisory levels (i.e., levels of exposure dangerous to human health) for both biological and chemical warfare agents. All components of the workshop included discussions on identifying regional and state research needs in areas homeland security. Several of the regional labs are currently working with NHSRC and the Office of Solid Waste and Emergency Response (OSWER) on validation of analytical methods for homeland security related threat agents, and NHSRC welcomes additional opportunities for collaboration.

Outcome

The workshops provided direct tech transfer and product awareness information to Region 1 which becomes valuable in its liaison role with NHSRC. The feedback to NHSRC regional and state research needs also provided an opportunity for fine-tuning of the research program from the experience gained by field staff which will lead to a tailored homeland security research program.

Contaminated Sediments in Region 2

Background

Consistent with Superfund regulations, a risk assessment is required for remedy selection decisions. For the Hudson River PCBs Superfund site, Region 2 developed a baseline human health risk assessment for this 200 mile site with significant input from the Office of Research and Development (ORD). The assessment evaluated a range of current and future exposure pathways, finding that the primary risks were associated with the ingestion of fish by adults, adolescents and young children living along the river. As part of the Remedial Investigation/Feasibility Study (RI/FS), EPA was challenged by the Potentially Responsible Parties (PRPs) on a number of issues including the exposure variables, toxicity values for both cancer and non-cancer health effects, and use of Probabilistic Risk Analysis (PRA). From these challenges, Region 2 developed a conceptual plan for the assessment including the application of PRA. At the time of document development, the guidance and policies on PRA were in the early stages of development. Region 2 worked with ORD scientists to develop a risk analysis responsive to the issues raised by the PRPs.

Science

Toxicity Values. EPA received numerous challenges to the cancer slope factor and the toxicity value used to assess the relative potency of PCBs. ORD's National Center for Environmental Assessment (NCEA) developed an Integrated Risk Information System (IRIS) chemical file for PCBs that was ultimately used in the assessment of risks. Throughout the development of the risk assessment, Region 2 worked with NCEA, the Superfund Human Health Technical Support Center in Cincinnati, and a National Risk Management Research Laboratory scientist on responses to toxicity questions for cancer and non-cancer assessments submitted by the PRPs (e.g., responses to five volumes of PRP comments on toxicity values and 93,000 individual comments received). The IRIS Chemical Manager for PCBs also met with community members in a debate with the PRPs' toxicologist and did an excellent job in responding to questions on the toxicity of PCBs, providing information understandable to the public.

Exposure Assumptions. Region 2 relied on the externally reviewed Exposure Factors Handbook developed by NCEA to identify studies and data to include in the PRA for the Hudson.

Probabilistic Risk Analysis (PRA). During risk assessment development, the use of the Monte Carlo technique in PRA was in its early stages. Region 2 worked with NCEA scientists to implement the PRA policies through coordination/discussion regarding datasets and the application of the technique. NCEA scientists also participated in the review of this document before submission for external peer review.

Outcome

The application of ORD science resulted in a risk assessment that passed an independent external peer review and was used in the decision that determined the need to remediate the site. It is anticipated that remediation of the river will begin in 2009. Due to the nature of the decisions (a projected cost of $460 million to remediate 2.65 million cubic yards of contaminated sediments) and the challenges on all aspects of the RI/FS by the PRPs and the public, it was important to have the expertise of ORD in the development of the risk assessment. The close coordination between Regional and ORD scientists can serve as a model for other projects where science is being applied in a time-sensitive manner.

Lowering Operation and Maintenance Costs of Superfund Pump-and-Treat Sites in Region 3

Background

A nationwide study was conducted by the Office of Solid Waste and Emergency Response (OSWER) as part of the 2001 Superfund Reform Strategy to identify opportunities to optimize operation and reduce cost associated with remedial sites. Of 88 pump-and-treat systems financed by the Superfund Program, 20 sites in Region 3 were selected for remediation system evaluations (RSE), a review process designed to optimize the remedies in operation at a Superfund site and lower operation and maintenance costs. Pump-and-treat systems are long-term remedies that experience substantial costs over the life of the operation. The RSEs were conducted by a team of regional, program office and ORD staff.

Science

Over the years ORD laboratories have conducted extensive research on monitoring performance and evaluation of pump-and-treat remediation systems, particularly systems dealing with dense non-aqueous phase liquids (DNAPLs). ORD's seminal contribution to optimization began with, *Methods for Monitoring Pump-and Treat Performance* in 1994. This research has been converted to technical reports and technical support to Superfund Remedial Project Managers for determining and evaluating remedies for Superfund site remediation.

The Ground Water Technical Support Center (GWTSC) of the Ground Water and Ecosystems Restoration Division in ORD's National Risk Management Research Laboratory in Ada, Oklahoma, is developing a guidance document tentatively entitled, *A Systematic Approach for Evaluation of Capture Zone at Pump and Treat Systems.* Additionally, the GWTSC conducted training courses for regional staff on how to apply the information provided in the guidance document.

The new guidance document updates the 2002 guidance document also developed at the GWTSC entitled *"Elements for Effective Management of Operating Pump and Treat Systems."*

Outcome

The optimization studies were conducted in EPA's Region 3 in two phases, involving two Superfund sites in phase one and eight Superfund sites in phase two. The Region 3 review team identified potential annual cost savings of $54,000 per year per site for sites in the first phase and savings of $130,000 per year per site for the eight sites in the second phase. These activities to realize the projected savings will improve the operation of the sites and free-up resources for use on other Superfund sites.

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ECOLOGICAL
RESEARCH PROGRAM

RESTORED STREAMS ENHANCE ABILITY TO REMOVE NITROGEN

Issue:
Excess nitrogen from fertilizer, septic tanks, animal feedlots, and runoff from pavement can threaten human and aquatic ecosystem health. Degraded ecosystems like those impacted by urbanization have reduced ability to process and remove excess nitrogen from the environment. Restoring ecological condition of streams may be a cost-effective, sustainable means to reduce nitrogen pollution in watersheds.

Science Objective:
Scientists at the U.S. Environmental Protection Agency's Office of Research and Development evaluated the effects of stream restoration on nitrogen removal capacity at an urban stream undergoing intensive restoration in Towson, Md.

Restoration of the stream was completed in 2005 using various techniques that reshaped the stream banks and channel, reconstructed natural stream features, and re-established riparian plants. Research began before restoration and continued afterwards to determine the effects of restoration practices on nitrogen removal.

Scientists found restored streams more effectively removed nitrate nitrogen than unrestored streams. The total amount of nitrogen removed in restored streams can be significant and may help to reduce the total nitrogen load reaching water bodies of concern like the Chesapeake Bay.

Application and Impact:
The research represents one of the most intensive efforts to date to quantify the effects of stream restoration on nitrogen processing in urban streams. Municipal natural resource agencies such as Baltimore County have used this information to help develop regional stream restoration strategies to improve ecosystem health and water quality. This research also has contributed to efforts by EPA's Chesapeake Bay Program to model the effects of stream restoration on Bay ecosystem health. Results of this ongoing research effort on stream restoration continue to be used to develop regional and national approaches to implementing and prioritizing stream restoration to manage nitrogen in watersheds.

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Office of Research and Development
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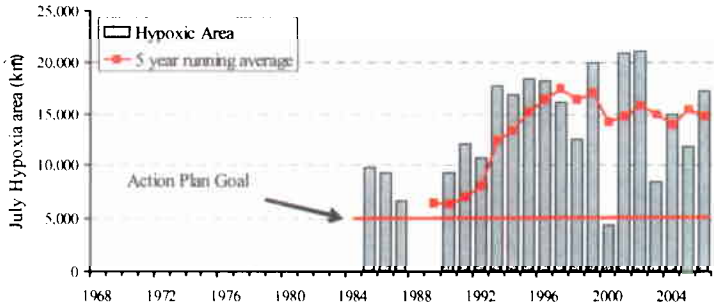
Gulf of Mexico Hypoxia Monitoring & Modeling

Improving the Science to Support Decision-Making

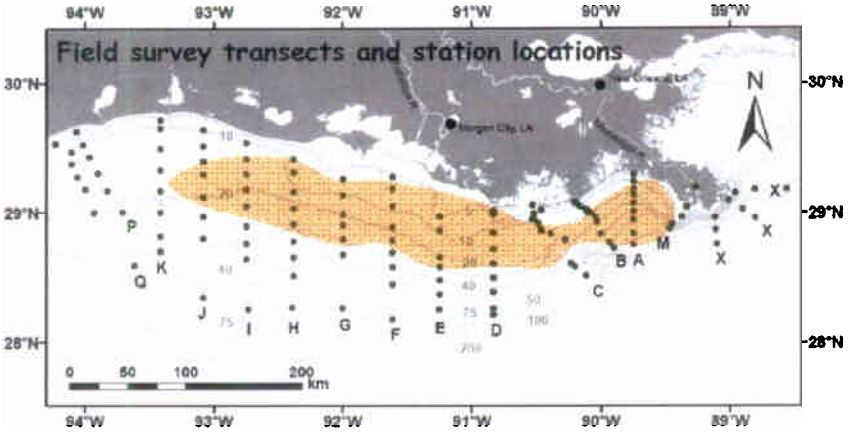
Every summer large areas of oxygen-depleted or hypoxic bottom waters develop in the northern Gulf of Mexico along coastal Louisiana. Current evidence indicates that the development, extent and persistence of hypoxia are caused by anthropogenic nutrient loading from the Mississippi-Atchafalaya River Basin. Nutrient loading to the northern Gulf has dramatically increased over the past several decades. The areal extent of the hypoxic zone has varied from year-to-year around the long term average of 13,000 km^2 - the maximum size was $\geq$20,000 km^2 (7,200 sq mi) in 1999, 2001 and 2002 and exceeded the size of Lake Ontario. The Action Plan for Reducing, Mitigating and Controlling Hypoxia in the Northern Gulf of Mexico (Mississippi River/Gulf of Mexico Watershed Nutrients Task Force, 2001) established goals to reduce the areal extent of hypoxia to 5,000 km^2 (1,800 sq mi) by 2015 and improve water quality in the Mississippi River Basin. http://www.epa.gov/msbasin/index.htm.



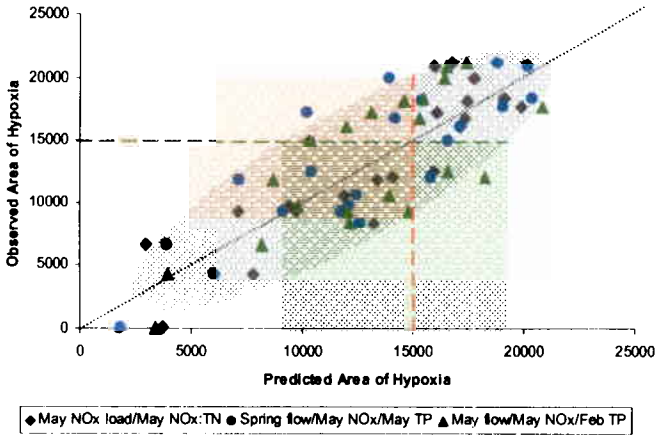
The US EPA's Office of Research and Development (ORD), in partnership with the Office of Water, Gulf of Mexico Program Office, and Regions 4 and 6 have developed and initiated a strategic framework that will help guide the science needed to address Gulf hypoxia and support nutrient management decisions. The goal is to develop a suite of model applications, data products and other tools to assess and predict the relationships between nutrient loads and Gulf hypoxia, quantify sources of error and uncertainty associated with nutrient load reduction targets, forecast the effects of nutrient management actions in the Basin on Gulf hypoxia, and provide defensible options to guide restoration and decision-making.

Seasonal Field Surveys: Seasonal field surveys are being conducted aboard the EPA Ocean Survey Vessel *BOLD* to characterize the temporal and spatial variability in oceanographic conditions and key biogeochemical processes influencing hypoxia. Data collected in spring and summer from stations across the Louisiana continental shelf, including a large suite of physical, chemical and biological parameters in the water column and sediments, are being incorporated into a geospatial database. The database will support the development of statistical models, and other modeling tools and applications.

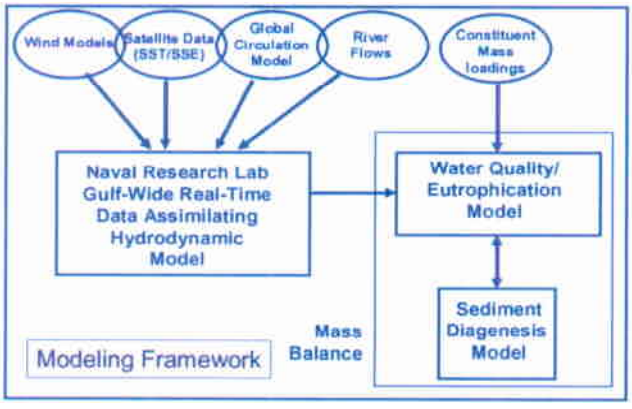
Multiple Regression Modeling: Initial modeling efforts focus on developing predictive relationships between the mid-summer size of hypoxia and flux of nutrients in the Mississippi and Atchafalaya Rivers using a multiple regression statistical analysis. Historical data on monthly nutrient flux are provided by the USGS NASQAN program from stations on the Mississippi (St. Francisville, LA) and Atchafalaya (Melville, LA) Rivers (http://co.water.usgs.gov/hypoxia/html/nutrients_new.html).



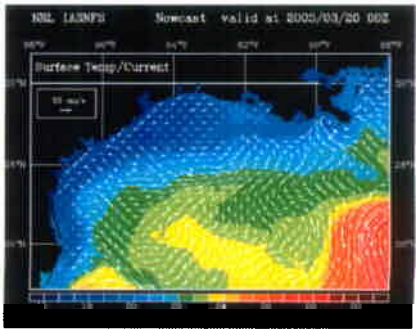
The analyses indicate that annual riverine loads of nitrate and other nutrients are poorly related to the midsummer size of hypoxia. In contrast, multiple regression models that incorporate the springtime delivery of nitrate and total phosphorus to the Gulf are good predictors of the midsummer size of hypoxia. Preliminary analysis suggests that the ensemble of these regression models predict the size of hypoxia within 30% of the observed size. Ongoing efforts are focused on quantifying the sources and magnitude of uncertainty associated with each model prediction.



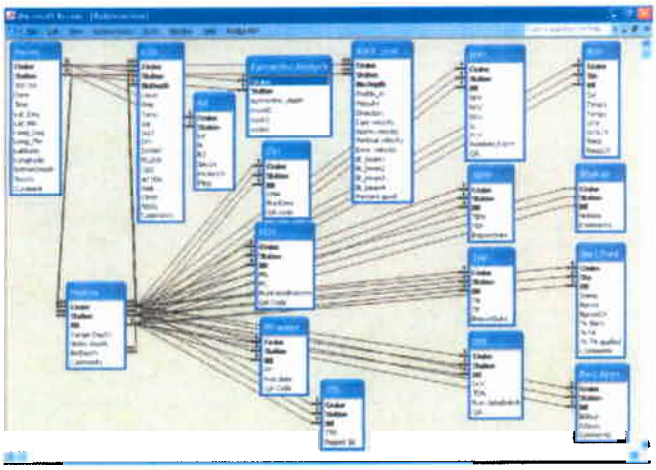
Coupled Hydrodynamic, Water Quality and Sediment Modeling: Coupled numerical models are under development to relate loadings and concentrations of riverine nutrients to water column and sediment biogeochemical processes that influence the development and size of hypoxic waters.



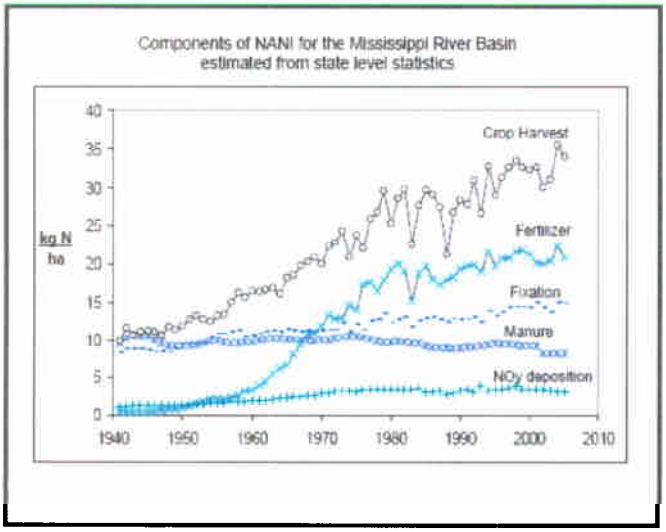
Ultimately, these models will be coupled to physical circulation and transport models and satellite ocean color remote sensing through an Interagency Agreement established with the Naval Research Laboratory - NRL operates a physical circulation model for the Gulf which provides the capability to track the transport of biogeochemical constituents in the coastal ocean. The development of integrated modeling capabilities will provide improved tools to assist federal, regional and state-based efforts to reduce watershed nutrient loads, improve Mississippi River Basin water quality, reduce the areal extent of hypoxic waters and restore and protect aquatic habitats and species.



Gulf Hypoxia Database Development: Although prior and ongoing federal, state and academic research programs have generated considerable information on Gulf hypoxia and nutrient dynamics, no effort has been undertaken to compile or link these datasets into a comprehensive database for use by natural resource managers or researchers. Region 6 and ORD are collaborating through the Regional Applied Research Effort (RARE) to develop a comprehensive geospatial relational database to assist technical and programmatic efforts by EPA Regions to characterize spatial and temporal patterns of nutrient concentrations, loads, and other water quality indicators. The database will aid efforts to develop water quality management strategies, indicators, targets, or other mechanisms to implement water quality provisions of the Clean Water Act for the purposes of protecting coastal and marine resources along the northern Gulf of Mexico.



Potential Impacts of Biofuels on Mississippi River Basin Water Quality and Gulf Hypoxia: The largest sources of nitrogen and phosphorus delivered to the Gulf of Mexico are derived from agricultural nonpoint sources within the tile-drained, corn/soybean landscapes of the Upper Mississippi and Ohio-Tennessee sub-basins. Expansion and intensification of corn production to support grain-based ethanol production and impacts of ethanol co-products on the animal industry are likely to cause major increases in nitrogen and phosphorus losses in the Basin and result in increasing nitrogen and phosphorus loads to the Gulf of Mexico. At present, the magnitude of the increase nutrient export resulting from ethanol production is uncertain due to a variety of factors including cropping patterns and demands for energy, food and animal feed, to name a few. The EPA SAB estimated that annual nitrogen loss may increase by 260 million pounds with an additional 16 million acres planted with corn. Cellulosic ethanol production can be less environmentally detrimental in many ways, but current technology and infrastructure do not make it competitive with grain-based ethanol. Nonetheless, it is clear that changing trends in landuse and agricultural practices in the Basin will create additional challenges to improve water quality, reduce watershed nutrient loads and reduce the areal extent of the Gulf hypoxic zone. Efforts to predict and forecast the impacts on hypoxic zone size from alternative nutrients management strategies will likely be influenced not only by improvements in water quality but also by renewable energy goals and demands for food and feed.



Contact: Rick Greene, USEPA Office of Research & Development, National Health & Environmental Effects Research Laboratory, Gulf Ecology Division: (850) 934-2497 or greene.rick@epa.gov.

Harmful Algal Blooms Observing System

Background

Within the Gulf of Mexico ecosystem, Harmful Algal Blooms (HABs) are significant features that have been reported since the first Spanish explorations to the region. In recent years more attention has been paid to these phenomena due to the public perception that blooms are more frequent and persistent. A part of this increased public awareness is likely based on the real impacts HABs can have on an ever-increasing coastal population. The toxins introduced into the ecosystem by a HAB event can seriously affect the health of both people and marine life, as well as tremendously disrupt local and regional economies. Coastal managers and researchers are now challenged to monitor, assess and even forecast these events in an effort to work towards minimizing these impacts.

Science

The Harmful Algal Blooms Observing System (HABSOS) is a regional coalition of U.S. and Mexican Federal and State agencies working together with international researchers. The HABSOS website is a regional, web-based data and information dissemination tool. This website provides a secure data entry tool for collection of cell count observations of the algal species *Karenia brevis*. Data entered into the system are aggregated and available for display in the HABSOS Internet Map Server (IMS). Online assessment and analysis of HAB events are enhanced through the integration of in-situ observations, surface forecasts, and powerful satellite imagery products into the IMS. A link is also provided to the official NOAA HAB Bulletin.

Outcome

The HABSOS and the BiNational HABSOS were developed and continue to be supported by the U.S. Environmental Protection Agency (EPA) Office of Research and Development, the EPA Office of Water Gulf of Mexico Program, and the NOAA National Coastal Data Development Center.

Increased Biofuels Refining in the Midwest

Background

A significant number of biofuel refineries are under construction and will be in operation in the next few years in Regions 5 and 7. The construction of additional biofuel refineries reflects projected demand for refining and increased investment in feedstock for ethanol production. Eight biofuel refineries are undertaking expansions to increase capacity by an additional 774 million gallons. Another 35 plants are under construction with production capacities exceeding 2.6 billion gallons, lifting the regional capacity to 6.3 billion gallons/year. Corn plantings in 2007 increased 15% over 2006. Projections by the Governors Ethanol Council suggest that new cellulosic technologies, in conjunction with the general growth in the industry, could quadruple ethanol production in the near term.

What will be the ecological effects of the enhanced growth of the biofuels industry in the Midwest? Recently EPA's Region 7 requested Office of Research and Development's (ORD) assistance to develop tools and scientific information to help the Region assess environmental issues relative to increased biofuel refining.

Science

ORD's Ecological Research Program (ERP) is focused on the study of *ecosystem services*, or the benefits to human well-being provided by ecological systems, such as provision of food and water, regulation of nutrients and climate, and opportunities for recreation. The ERP has developed the Future Midwestern Landscapes (FML) Study to help Regions 5, 7 and 8 understand how alternative trajectories for biofuels development can affect ecosystem services in the Midwest. For a study area that covers Regions 5 and 7, plus the Dakotas and Montana, the study will construct and map future scenarios ranging in emphasis from corn-ethanol to cellulosic ethanol production. Ecosystem services associated with each of these alternative landscapes will be estimated and compared.

Outcome

The FML Study seeks to: 1) understand how current and projected land uses affect the ecosystem services provided by Midwestern landscapes; 2) provide spatially explicit information that will enable EPA Regions and Programs to articulate sustainable approaches to environmental management; and 3) develop web-based tools depicting alternative futures so users can evaluate trade-offs affecting ecosystem services. Outcomes to be measured are uses of study results and web-based tools by decision-makers at national, regional and local levels. Presently ORD is collaborating with Region 7 to establish RARE projects that will carry out some of the needed work, and to engage stakeholders in envisioning future Midwestern landscapes. Through the Midwest Spatial Decision Support System Partnership, Region 5 is collaborating in the development of online decision support tools.

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ECOLOGICAL RESEARCH PROGRAM

NEW METHODS AND TOOLS FOR MONITORING COASTAL WATERS

Issue:

Our nation's Great Lakes and estuaries are highly productive ecosystems that serve both economic and recreational purposes but are under severe stress from increasing population. They provide ecosystem services that support forestry, agriculture, shipping, and sporting and leisure activities. New tools are necessary to evaluate the health of these coastal waters, predict future conditions, and identify solutions to threats to these services.

Science Objective:

The Science to Achieve Results (STAR) program, a part of the U.S. Environmental Protection Agency's Office of Research and Development, established five Estuarine and Great Lake (EaGLe) research projects with university consortia to develop the next generation of coastal ecological indicators. An ecological indicator is a measure that describes the condition of an ecosystem or one of its critical components. The EaGLe indicators can be used to assess coastal conditions, monitor trends, and diagnose causes of impairment.

Application and Impact:

EaGLe researchers have developed 65 new or improved coastal indicators for evaluating ecosystem conditions in environments ranging from small individual coastal habitats to entire regions. These tools and methods are being adopted or considered for adoption by states, regions, and others to provide a comprehensive coastal monitoring program. For example, these procedures provide environmental resource managers with the ability to identify wetlands that are vulnerable to loss or coastal areas in need of protection or restoration, as well as a mechanism to monitor change over time.

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EaGLE Web site:
http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/outlinks.centers/centerGroup/6

EaGLE consortiums Web site:
http://eagle.nrri.umn.edu/pubdefault.htm

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June 2007

Fort Chafee Asbestos Testing: Alternative Asbestos Control Method (AACM)

Background

A few years ago, the mayor of Ft. Worth, TX commented to the Region 6 Regional Administrator (RA) that the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulatory requirements for demolition were severely hampering the efforts of Fort Worth to revitalize blighted areas. In particular, asbestos-containing residences were necessitating much longer times for demolition, thus incurring higher costs. The RA placed a high priority on finding a method of demolition that allows faster and less-expensive demolition of structures while protecting human health and the environment.

Science

In order to develop an alternative asbestos control method, it was necessary to have asbestos-containing structures in a remote location to insure public safety. The Fort Chaffee location in Arkansas was chosen for the project. As with other demolition involving Regulated Asbestos-Containing Material (RACM), insulation and fireproofing materials are removed by hand and disposed of in a RACM-designed facility. However, other asbestos material, such as shingles, siding, flooring materials, and wallboard are being left in place. The structure is then wetted with water containing surfactants (similar to firefighting foam). Once properly wetted, the structure is demolished using standard demolition equipment. Air quality is captured during these demolition activities, and the results analyzed.

The Office of Research and Development has been involved in planning and set-up of the AACM, and is also conducting oversight of test results. Initial results appear to be promising, but tests are still underway.

Outcome

The AACM can be done in a fraction of the time needed for a standard NESHAP demolition, and with corresponding cost savings. If it can be shown that the AACM procedure is as protective, if not more protective, than the current standard, then communities would have a new tool to accelerate the cleanup and revitalization of blighted areas. This tool would have the potential to result in faster, less-expensive demolitions, which would allow scarce civic resources to be stretched further for the good of the community.

Characterization/Remediation of Mine Waste in Region 8

Background

Mine waste and acid mine drainage (AMD) associated with operational and historic abandoned hard rock metal mines are significant environmental problems in many regions of the U.S., particularly in the western part of the country, as well as world-wide. Problems include waste rock and tailings left in place; erosion of these materials; acid mine drainage (AMD), other mining-influenced waters; increased loads of acidity, metals, and solids to streams; discharges to groundwater; exceedances of water quality standards; toxicity to humans and aquatic and terrestrial biota; and other ecological and socioeconomic impacts. Metals fate and transport modeling is needed for characterization, as well as remedial planning and design, in mining-impacted watersheds.

Science

Due to complex biogeochemical processes, however, modeling metals can be difficult, and there are only a few models in use capable of modeling metals fate and transport incorporating the most important processes. The EPA Water Quality Analysis Simulation Program (WASP7) can be used for relatively simple metals modeling, while WASP in conjunction with the Metals Transformation and Assessment (META4) model (also developed by EPA) can be used for more complex modeling. In addition, the USGS One-Dimensional Transport with Equilibrium Chemistry (OTEQ) model has been used more widely for metals in recent years at EPA funded Colorado State University and the Rocky Mountain Regional Hazardous Substances Research Center (RMRHSRC) to develop the Two-Dimensional Runoff with Erosion and Export (TREX), an advanced watershed contaminant transport model used for metals associated with sediment.

The National Risk Management Research Laboratory's (NRMRL) Engineering Technical Support Center (ETSC) has also been providing support to the regions on a wide range of mine waste innovative remediation technology projects throughout the U.S. One of the most prominent semi-passive technologies for AMD is the use of sulfate-reducing bacteria bioreactors (SRBs) for precipitation of metal sulfides and subsequent settling out of solution. The ETSC has been a leader in developing this technology, and has implemented successful demonstrations in several regions. The ETSC is also studying the microbiological aspects of these bioreactors, working with researchers at the Colorado School of Mines, Colorado State University, and the Rocky Mountain Region Hazardous Substances Research Center (RMRHSRC) to understand issues regarding what makes them fail, what are the rate limiting reactions inside the cells, how can we make them smaller and more efficient, etc.

Outcome

The Office of Research and Development's (ORD) research has improved characterization of mining sites in complex mineralized zones (e.g., Upper TenMile Creek Mining Area and Basin Mining Area Superfund Sites, Montana and Leviathan Mine Superfund Site, California) and has led to the identification of more successful remedial remedies for these sites.

Perchlorate in Region 9

Background

Perchlorate has been used in solid rocket fuels and propellants since the early 1900s. Environmental perchlorate contamination was first discovered in wells at California Superfund sites in 1985, a reflection of the substantial presence of the defense and space industry in that state. Confirmed releases of perchlorate occurred in twenty states with the majority of these releases in California, Nevada, Arizona and Texas.

EPA has estimated that eleven million people have perchlorate in their public drinking water supplies at levels of at least 4 parts per billion. Perchlorate in the Colorado River is believed to be the source of perchlorate found in leafy vegetables such as cabbage and lettuce in California and has conducted research to determine bioaccumulation.

Perchlorate compounds have been found to be endocrine disruptors with deleterious effects on human health.

Science

The Office of Research and Development (ORD) continues to advise the Region 9 on scientific developments in the toxicity of perchlorate, and interpretation of the toxicity to assist in developing cleanup plans at Superfund sites in the Region. The FY01 RARE (Regional Applied Research Effort) project to develop a sensitive chemical analytical method for the detection of perchlorate in ambient waters with high total dissolved solids (TDS) was completed in 2005. ORD collaborated with the Superfund program to analyze perchlorate in highly saline water entering the Salton Sea in California to test the efficacy of the new method on real-world samples. The Salton Sea is the highly evaporated, below-sea-level sink for the majority of flow of the Colorado River. The sampling and analysis effort successfully demonstrated robust sampling and analytical methods.

Outcome

The analytical expertise was useful in advising Superfund project managers how to examine perchlorate in complex media such as wastewater treatment plants and sewer lines. This work will lead to scientifically defensible risk management decisions at a number of sites in Region 9.

Williamette River Basin

Background

Economic constraints and the problem of non-point source pollution have proved considerable impediments to the US EPA's goals of pollution reduction. Traditional EPA cost-benefit analyses are primarily performed for single issue problems, and often prove ineffective for evaluating large areas for extended periods of time. Moreover, they lack the sophistication to understand how proposed decisions will affect aggregate ecosystems. This is particularly true for pollution resulting from land use practices and such widely dispersed pollutants as nitrogen, ozone and carbon dioxide.

The Williamette River Basin (WRB) in western Oregon has a drainage area of 29,727 square km and has the thirteenth highest streamflow of rivers in the U.S. The WRB is primarily composed of forests, diversified agriculture, with a relatively small and growing urban and suburban sector. Thus pollution in the river basin cannot be traced to a single or series of point-sources, and its reduction depends on EPA regulations and policies affecting ecosystem services.

Science

The Williamette Ecosystems Project (W-ESP) has stated goals of developing the "scientific basis to apply ecosystem service concepts to the multitude of environmental issues facing the EPA in a 'Place-Based' context." The notion of multiple, linked ecosystem services can be viewed as "bundled services" and is a key component of this proposed research project.

The project will 1) Identify crucial knowledge gaps in the ecological processes underlying ecosystem services in the WRB 2) Develop an approach to inventory and map ecosystem services in the WRB based on current conditions and available data 3) Quantify the response of ecosystem services to current and projected conditions and stressors 4) Quantify linkages and trade-offs among bundles of ecosystem syervices in response to land use, climate and other forcing variables 5) Provide a model-based approach that values and projects future responses of bundled ecosystem services to probable future conditions.

Outcome

The key end product of this work will be a linked, validated ecosystem model with a user-friendly interface that will be used by decision makers to evaluate possible outcomes affecting ecosystem services based on their regulatory decisions in the WRB. The eventual future goal is to link up the place-based model to the broader landscape of the United States.

Columbia River Basin

Background

In EPA's 2006-2011 Strategic Plan, the Columbia River Basin was elevated to one of our Nation's Great Water Bodies, joining the six other Great Water Bodies in *Goal 4: Healthy Communities and Ecosystems*, focused on protecting, sustaining and restoring the health of critical natural habitats and ecosystems. The Columbia River Basin covers a major portion of the landscape of North America, including parts of seven states and British Columbia. As a large and important ecosystem, it is home to what were once the largest runs of salmon and steelhead in the world.

EPA studies and state monitoring programs have found significant levels of toxins in fish and the waters they inhabit within the basin. Accumulation of toxins in fish, among other environmental stressors, threatens the survival of fish species, and human consumption of these fish can lead to health problems. Many governments, communities and citizens have rallied to launch a long term and intense recovery effort to restore these remarkable fish, but the large size of the Columbia River Basin has proved a considerable challenge in attempting to map out the river and assemble a plan for remediation.

Science

The Environmental Monitoring and Assessment Program (EMAP) uses unbiased statistical designs, similar to census bureau surveys, and sensitive biologic indicators (e.g. plants, invertebrates and fish) to estimate the condition of waterways. These biological indicators are used because they are critical parts of freshwater ecosystems, and because they are particularly good at responding to stressors in the surrounding environment. Moreover, the uniquely random and systematic design allows local samples to be taken in such a way to suggest larger, regional conclusions over the entire length of the river.

In the EMAP approach, an initial assessment establishes a baseline condition for a given type of water ecosystem (in this case the Columbia River). That baseline can then be compared to follow-up detection of changes and trends in a large ecosystem over time.

Outcome

The utilization of EMAP in the Columbia River Basin has allowed researchers to monitor stress indicators like water chemistry, watershed condition, instream physical habitat and riparian condition, benthic macroinvertebrate assemblage and vertebrate assemblage on a regional scale. EMAP has provided a solution to the problems involving isolated and non-representative sampling sources. Thus it has allowed scientists, conservationists and politicians to communicate in terms of stream length and ecoregion, instead of the previous, more provincial constraint to the immediate area surrounding sample data.